

CLAIMS

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1. A magnetic thin film consisting of an iron carbide film, said iron carbide film comprising an α' phase as a principal phase and at least carbon and iron as constituent elements.

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2. A magnetic thin film according to claim 1, wherein said iron carbide film consists of a single α' phase.

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3. A magnetic thin film according to claim 1, wherein a diffraction peak from the (002) plane of the α' phase is observed as a principal peak by means of an X-ray diffraction method or an electron diffraction method in said iron carbide film.

4. A magnetic thin film according to claim 1, wherein said iron carbide film has a body-centered tetragonal structure and an c-axis constitutes an axis of hard magnetization and, furthermore, a c-plane constitutes a plane of easy magnetization.

Sub D1
5. A magnetic thin film according to claim 4, wherein said iron carbide film has a magnetic anisotropy energy required when the spontaneous magnetization deflects toward the direction of the c-axis from the c-plane, which is two orders

of magnitude larger than the magnetic anisotropy energy required when spontaneous magnetization deviates from the direction of the axis of easy magnetization in the c-plane.

6. A magnetic thin film according to claim 4, wherein said axis of hard magnetization constitutes a direction which is generally perpendicular to the film surface and said plane of easy magnetization constitutes a direction, which is generally horizontal to the film surface.

7. A magnetic thin film according to claim 1, wherein said iron carbide film consists of not less than 0.5 atomic % and not more than 15 atomic % of carbon and iron as the balance.

8. A magnetic thin film according to claim 1, wherein said iron carbide film consists of not less than 1 atomic % and not more than 12 atomic % of carbon and iron as the balance.

9. A magnetic thin film according to claim 1, wherein said iron carbide film contains cobalt as a third element.

10. A magnetic thin film according to claim 1, wherein said iron carbide film contains nitrogen as a third element.

11. A magnetic thin film according to claim 1, wherein said

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iron carbide film is formed on a thin film having almost the same interatomic distance as that of said iron carbide film.

12. A magnetic thin film according to claim 11, wherein the principal element constituting said thin film has almost the same lattice constants as those of said iron carbide film.

13. A magnetic thin film according to claim 11, which is an iron film having the (200) plane as the surface.

14. A magnetic thin film according to claim 11, wherein the principal element constituting said thin film is at least one element selected from Ag, Au, Pd, Pt, Rh, Al, Ir, and Ru.

15. A magnetic thin film according to claim 1, wherein said iron carbide film has negative magnetocrystalline anisotropy constants K_u .

16. A method of producing a magnetic thin film, which comprises the step of forming an iron carbide film comprising an α' phase as a principal phase and at least carbon and iron as constituent elements on a substrate disposed in a vacuum space by using any film forming method of a sputtering method, a vacuum deposition method, a CVD method, an ion beam method, and a laser deposition method.

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17. A method of producing a magnetic thin film according to claim 16, wherein the surface temperature of said substrate is adjusted to not less than 5°C and not more than 100°C during the formation of said iron carbide film.

18. A method of producing a magnetic thin film according to claim 16, wherein the surface temperature of said substrate is adjusted to not less than 10°C and not more than 70°C during the formation of said iron carbide film.

19. A method of producing a magnetic thin film according to claim 16, which comprises the step of heat-treating said substrate in a vacuum space, the step of forming a thin film having almost the same interatomic distance as that of said iron carbide film on a substrate heat-treated in a vacuum space by using any film forming method of a sputtering method, a vacuum deposition method, a CVD method, an ion beam method, and a laser deposition method, and the step of cooling the substrate on which said thin film is formed to at least 100°C or lower, before the step of forming said iron carbide film.

20. A method of producing a magnetic thin film according to claim 16, wherein the step of forming said iron carbide film comprises depositing an iron carbide film on a substrate by

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using an alloy or sintered base metal consisting of at least carbon and iron, or a composite base metal of a combination of a base metal consisting of carbon and a base metal consisting of iron, as a base metal source for forming said iron carbon film, and a process gas consisting of an inert gas.

21. A method of producing a magnetic thin film according to claim 16, wherein the step of forming said iron carbide film comprises depositing an iron carbide film on a substrate by using a base metal consisting of at least iron, as a base metal source for forming said iron carbon film, and a process gas consisting of a reactive gas containing carbon as a constituent element.

22. A method of producing a magnetic thin film according to claim 20, which comprises using, as said alloy or said sintered base metal, a material with a composition consisting of not less than 0.5 atomic % and not more than 15 atomic % of carbon and iron as a balance.

23. A method of evaluating a magnetic thin film, which comprises using an X-ray diffraction method as a means for specifying said magnetic thin film as an iron carbide film comprising an α' phase as a principal phase and at least carbon and iron as a constituent element.

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24. A method of evaluating a magnetic thin film, which comprises using an electron diffraction method as a means for specifying said magnetic thin film as an iron carbide film comprising an α' phase as a principal phase and at least carbon and iron as constituent elements.

25. A magnetic head comprising the magnetic thin film consisting of an iron carbon film of ^{claim 1} ~~any one of claims 1 to 15~~ as at least a portion of a magnetic pole material of a recording head.

26. A magnetic head according to claim 25, wherein said recording head is for longitudinal magnetic recording.

27. A magnetic head according to claim 25, wherein said recording head is for perpendicular magnetic recording.

28. A magnetic recording device comprising the magnetic head of claim 25, capable of magnetically recording information on a moving magnetic recording medium using said magnetic head.

29. A magnetic recording device according to claim 28, wherein said magnetic recording medium has an axis of easy magnetization in a direction which is parallel with or

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perpendicular to a substrate.

30. A magnetic device comprising a hard magnetic film which serves as a recording layer constituting a longitudinal magnetic recording medium, and a magnetic thin film consisting of the iron carbide film of ^{claim 1} ~~any one of claims 1 to 15~~, which is formed on said hard magnetic film.

31. A magnetic device according to claim 30, wherein an intermediate layer consisting of a non-magnetic film is formed between said magnetic thin film and said hard magnetic film.

32. A magnetic device comprising a hard magnetic film which serves as a recording layer constituting a perpendicular magnetic recording medium, and a magnetic thin film consisting of the iron carbide film of ^{claim 1} ~~any one of claims 1 to 15~~, which is formed under said hard magnetic film.

33. A magnetic device according to claim 32, wherein an intermediate layer consisting of a non-magnetic film is formed between said magnetic thin film and said hard magnetic film.

34. A magnetic device comprising the magnetic thin film consisting of an iron carbide film of ^{claim 1} ~~any one of claims 1 to 15~~ used as a soft magnetic layer constituting an

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35. A magnetic device comprising the magnetic thin film consisting of an iron carbide film of ^{claim 1} ~~any one of claims 1 to 15~~ used as a soft magnetic layer constituting a spin transistor magnet.

36. A magnetic device comprising the magnetic thin film consisting of an iron carbide film of ^{claim 1} ~~any one of claims 1 to 15~~ used as at least a portion of a transmission line constituting a magnetic sensor.

37. A magnetic device comprising the magnetic thin film consisting of an iron carbide film of ^{claim 1} ~~any one of claims 1 to 15~~ used as at least a portion of a transmission line constituting a high frequency passive device.

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38. A magnetic device comprising the magnetic thin film consisting of an iron carbide film of ^{claim 2} ~~any one of claims 1 to 15~~ used as at least a portion of a magnetic film constituting a micro transformer or a micro inductor.

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